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(54) PRODUCTION OF FOAMED HIGHLY INORGANIC-FILLED POLYSTYRENE RESIN SHEET

(57)Abstract:

PURPOSE: To obtain the title sheet having a low calorific value of burning and high safety without detriment to the properties of the obtained form by extrusion-foaming a foammable molten resin composition comprising a specified amount of an inorganic filler and a specified copolymer from an extruder into a low-pressure zone.

CONSTITUTION: A foammable molten polystyrene resin containing 10–40wt.% inorganic filler, 0.1–1.5wt.% volatile blowing agent and 0.1–1.0wt.% polyethylene glycol/propylene glycol copolymer is foamed by extrusion from an extruder into a low-pressure zone to obtain the sheet having a thickness of 0.7–2.0mm and an average cell diameter of 30–3000μm. The above process is free from problems such as the formation of a corrugate due to the division of bubbles during extrusion foaming, the break of bubbles by the inorganic filler, and the embrittlement of the foamed sheet. The obtained sheet has a low calorific value of burning, and is highly safe and desirable for food packaging containers.

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CLAIMS

[Claim(s)]

[Claim 1] The manufacture approach of the inorganic filler quantity restoration polystyrene system resin foaming sheet which a low-pressure area carries out extrusion foaming of the melting polystyrene system resin of the fizz containing 10 – 40% of the weight of an inorganic filler, and 0.1 – 1.5% of the weight of a volatile foaming agent and 0.1 – 1.0% of the weight of a polyethylene-glycol-polypropylene-glycol copolymer from the inside of an extruder, and is characterized by obtaining the foaming sheet of 3 and thickness of 0.7–2.0mm with a consistency of 0.1–0.5g [/cm], and 30–300 micrometers of diameters of average air bubbles.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]**[0001]**

[Industrial Application] The combustion calorie of this invention is low and it is related with the manufacture approach of an inorganic filler quantity restoration polystyrene system resin foaming sheet suitable also as an object for shaping of the container for food packing.

[0002]

[Description of the Prior Art] Since especially a disposable container occupies many of plastic wastes, the disposal approach is examined these days when a close-up of the problem of processing of a plastic waste is taken. In order for a disposable container to process from before, incineration processing was mainly adopted, and these containers had the problem that an incinerator was damaged and a life became short with the high temperature energy generated at the time of combustion, when the combustion calorie was high and carried out incineration disposal of a lot of disposable containers compared with paper or wood, since ** was a product made from plastics.

[0003] As an approach of reducing the combustion calorie of plastics, it is well-known to be filled up with inorganic fillers, such as a calcium carbonate, a magnesium carbonate, talc, and clay, into plastics (for example, JP,56-3376,B, JP,63-38060,B, etc.).

[0004] However, since the foaming sheet which contains an inorganic filler in large quantities becomes weak, by the approach given in JP,56-3376,B, by carrying out reaction covering of the front face of an inorganic filler by polymerization nature organic acids, such as an acrylic acid and a methacrylic acid, it has solved the above-mentioned problem and has solved it by adding a part for rubber in resin by the approach given in JP,63-38060,B.

[0005] However, the approach of carrying out reaction covering of the front face of an inorganic filler by the polymerization nature organic acid has some by which the problem in the field of safety is not solved on food sanitation hygiene, when using a foaming sheet for shaping of a food container etc.

[0006] Moreover, although the approach of carrying out [the approach] extrusion foaming to the shape of a tube from the circular die which prepared the resin constituent of fizz at the tip of an extruder, and clearing this tube and using as a foaming sheet is widely adopted when manufacturing a foaming sheet The air bubbles at the time of foaming tend to make an inorganic filler detailed in order to act also as a nucleating additive. For this reason, by the latter approach, corrugated one occurred in the foaming tube which carried out extrusion foaming from the circular die, the appearance of a foaming sheet became bad, especially HIDA corrugated when corrugated one is severe welded mutually, and there were problems, like extrusion foaming becomes difficult. Furthermore, since the inorganic filler made the hole in the cellular film at the time of formation of the cellular film consequently, foaming effectiveness worsened, the foaming agent was needed for the large quantity, and it also had the problem of the rate of a closed cell of the foaming sheet obtained falling.

[0007] this invention person etc. came to complete a header and this invention for the above-mentioned conventional trouble being solvable by considering as the foaming sheet which a low-pressure area carries out extrusion foaming of the polystyrene system resin constituent of the

fizz which contains an inorganic filler and a polyethylene-glycol-polypropylene-glycol copolymer at a specific rate from the inside of an extruder, and has a specific consistency, thickness, and a diameter of air bubbles, as a result of inquiring wholeheartedly in view of the above-mentioned point.

[0008]

[Means for Solving the Problem] Namely, the manufacture approach of the inorganic filler quantity restoration polystyrene system resin foaming sheet of this invention The melting polystyrene system resin of the fizz containing 10 – 40% of the weight of an inorganic filler, and 0.1 – 1.5% of the weight of an volatile foaming agent and 0.1 – 1.0% of the weight of a polyethylene-glycol-polypropylene-glycol copolymer A low-pressure area carries out extrusion foaming from the inside of an extruder, and it is characterized by obtaining the foaming sheet of 3 and thickness of 0.7–2.0mm with a consistency of 0.1–0.5g [/cm], and 30–300 micrometers of diameters of average air bubbles.

[0009] As polystyrene system resin used in this invention, a copolymer with other vinyl monomers, such as a polymer of alkenyl aromatic compounds, such as polystyrene and PORIPA lame chill styrene, an alkenyl aromatic compound, an acrylic acid, a methacrylic acid and a maleic anhydride, and acrylonitrile, etc. is mentioned, for example. In this invention, parts for rubber, such as a styrene-butadiene-rubber block copolymer, a styrene-butadiene-rubber random copolymer, butadiene rubber, ethylene-propylene rubber, ethylene rubber, and polyisoprene rubber, can also be added to the above-mentioned polystyrene system resin. As for a rubber component, it is desirable to add about 0.3 to 10% of the weight to polystyrene system resin.

[0010] As an inorganic filler used for this invention, talc, a calcium carbonate, a magnesium carbonate, carbon black, clay, etc. can use the general inorganic filler used for this kind of application from before. The particle size of the inorganic filler used changes with classes of inorganic filler. Although it is about 0.5–100 micrometers in mean particle diameter, in the case of talc, in the case of the mean particle diameter of 1.5–15 micrometers, and a calcium carbonate, a thing with a mean particle diameter of 1.5–6.0 micrometers is generally, desirable, for example.

[0011] The polyethylene-glycol-polypropylene-glycol copolymer (it is hereafter called a PEG-PPG copolymer for short.) added in polystyrene system resin with the above-mentioned inorganic filler is a block copolymer of ethyleneoxide and propylene oxide, and is known as a high molecular surface active agent. By using a PEG-PPG copolymer together with an inorganic filler, by improving familiarity by the interface of an inorganic filler and polystyrene system resin, and foaming effectiveness's improving, and improving the solubility to the resin of a foaming agent, the diameter of air bubbles is enlarged and it is thought that corrugated generating is prevented. Especially a PEG-PPG copolymer has [1000 or more things] effectiveness in corrugated prevention and has the desirable weight average molecular weight of a PPG component. The rates of the PEG component and PPG component in a PEG-PPG copolymer are 80:20–10:90 in a weight ratio. Moreover, as a PEG-PPG copolymer, the thing of the both-ends PEG mold with which the PEG component was combined with the both sides of a PPG component is desirable.

[0012] The content in expandable polystyrene system resin adds the above-mentioned inorganic filler and a PEG-PPG copolymer, respectively so that it may become 10 – 40 % of the weight, and 0.1 – 1.0 % of the weight.

[0013] It may reduce the combustion calorie of a polystyrene system resin foaming sheet so that an inorganic filler has many additions, but since air bubbles make it detailed, corrugated one will occur, or decline in the rate of a closed cell or foaming effectiveness will be caused and the moldability and many physical properties of a sheet will fall further if an inorganic filler also has the operation as a nucleating additive and it is made to contain so much, generally the addition of an inorganic filler is less than 5 % of the weight. The relation between the addition of an inorganic filler at the time of adding an inorganic filler and the combustion calorie of a foaming sheet is shown in a polystyrene foaming sheet at drawing 1.

[0014] On the other hand, although a foaming sheet becomes [the appearance of a sheet] poor and is not desirable even if air bubbles are too coarse, a foaming sheet also with a good appearance is obtained by this invention approach, without causing the fall of corrugated generating, the rate of a closed cell, foaming effectiveness, a moldability, and many physical

properties in the range whose content of an inorganic filler is 1 – 40 % of the weight by having used together with the PEG-PPG copolymer. However, when the content of an inorganic filler exceeds 40 % of the weight, while kneading of a constituent becomes difficult also by this invention approach, since the elongation of a sheet worsens, extrusion-foaming nature and the moldability of a sheet fall and effectiveness of a fall of a combustion calorie cannot be conversely desired at less than 10 % of the weight, it is not desirable. The desirable content of the inorganic filler in a fizz resin constituent is 10 – 35 % of the weight.

[0015] Although the elongation at the time of foaming worsens, cutting of a sheet etc. will arise at the time of the taking over of a foaming sheet or a moldability will tend to become poor when there are many especially amounts of an inorganic filler if it fills up with an inorganic filler into a fizz resin constituent, the elongation of a foaming sheet is improved by addition of a PEG-PPG copolymer. However, since the slipping phenomenon of resin arises within an extruder, and sufficient discharge quantity is not obtained but it will be in the condition of extrusion-foaming impossible if the addition of a PEG-PPG copolymer can prevent neither corrugated generating accompanying the brittle problem and detailedizing of air bubbles which are produced by having added the inorganic filler at less than 0.1 % of the weight, nor the decline in foaming effectiveness but exceeds 1.0 % of the weight conversely, it is not desirable.

[0016] as an approach of adding and kneading an inorganic filler to polystyrene system resin, the dryblend method, the masterbatch method (the following and MB — it is called law for short.), etc. mention — having — MB — it is desirable when law raises the addition of an inorganic filler. Moreover, the addition of an inorganic filler can be raised also by using the large talc of slippage etc. as an inorganic filler.

[0017] When adopting the describing [above] MB method, brittleness, such as tensile strength of a foaming sheet, can be improved by making into 2 – 12g / 10 minutes MI of the masterbatch (MB) in which MI contains an inorganic filler, using the thing for 4–15g / 10 minutes as base material resin.

[0018] As an volatile foaming agent used in this invention approach, halogenated hydrocarbon, such as aliphatic hydrocarbon [, such as a propane, butane, a pentane, a hexane and a heptane], trichloromonofluoromethane, dichlorodifluoromethane, 1, and 1-difluoro-1-chloroethane, 1, and 1-difluoroethane, 1, 2-tetrafluoro ethane, 1, 1 and 1, 2-tetrafluoro-2-chloroethane, difluoro chloromethane, a methyl chloride, and a methylene chloride, etc. is mentioned. When trichloromonofluoromethane and a dichlorodifluoromethane are used as a foaming agent Although there are few possibilities that corrugated one etc. may occur even if it makes an inorganic filler contain so much, since trichloromonofluoromethane, a dichlorodifluoromethane, etc. produce the environmental problem of ozone layer depletion among halogenated hydrocarbon, The difluoro chloromethane which destroys neither aliphatic hydrocarbon nor an ozone layer as an volatile foaming agent, It is desirable to use halogenated hydrocarbon, such as 1, 1, 1, 2-tetrafluoro-2-chloroethane, 1, 1 and 1, 2-tetrafluoro ethane, 1, and 1-difluoroethane, 1, and 1-difluoro-1-chloroethane.

[0019] In addition, in this invention, foaming agents, such as a carbon dioxide, nitrogen, and water, can also be used together with an volatile foaming agent. 0.1 to 1.5% of the weight, preferably, the content in a resin constituent adds an volatile foaming agent so that it may become 0.3 – 0.5 % of the weight.

[0020] Although the melting polystyrene system resin of the fizz containing the above-mentioned inorganic filler, a PEG-PPG copolymer, and a foaming agent is made to extrude and foam to a low-pressure area from the inside of an extruder and a foaming sheet is obtained by this invention approach, this foaming sheet is a consistency 0.1 – 0.5 g/cm³, the thickness of 0.7–2.0mm, and 30–300 micrometers of diameters of average air bubbles, and is 40–200 micrometers of diameters of average air bubbles preferably.

[0021] While corrugated generating prevention conjointly is achieved with having used together the inorganic filler and PEG-PPG copolymer of the amount of specification by making the consistency of a foaming sheet, thickness, and the diameter of average air bubbles into the above-mentioned range, even if it contains the inorganic filler so much, the brittleness of a foaming sheet etc. is improved, a moldability becomes good and, moreover, appearances, such as

smooth nature, also become good. Furthermore, while destruction of the cellular film by the inorganic filler is prevented, as a result of the compatibility of a foaming agent and resin becoming good, stable extrusion foaming becomes possible and fluctuation of expansion ratio decreases.

[0022] Combination, such as a class (difference in MI etc.) of the addition of an inorganic filler, the class of foaming agent, an addition, and base material resin, can adjust the consistency of the above-mentioned foaming sheet. Although adjustment of the consistency at the time of foaming will generally become difficult if an inorganic filler is added, density regulation of the foaming sheet obtained can be easily performed by having used the PEG-PPG copolymer together. Moreover, the thickness of a foaming sheet is determined by adjustment of the discharge quantity of an extruder, and the interrelation of the taking over rate of an extrusion-foaming object. Furthermore, the diameter of average air bubbles of a foaming sheet is adjusted by combination, such as an addition of an inorganic filler, a class, and a class of foaming agent.

[0023] The method of carrying out extrusion foaming, obtaining tube-like foam, clearing the foam of the shape of this tube along with the direction of extrusion subsequently, and usually obtaining a sheet from the circular die at the tip of an extruder, as an approach of obtaining a foaming sheet, is adopted.

[0024] In addition, since the foaming sheet obtained in this invention approach contains an inorganic filler, it asks for expansion ratio from the consistency of this foaming sheet from the following and the formula shown by several 1.

[0025]

[Equation 1]

$$\text{発泡率 (倍)} = \frac{1.05 \text{ (g/cm}^3\text{)}}{\text{シートの密度 (g/cm}^3\text{) } \times (100 - \text{フィラー含有量 (\%)}) / 100}$$

[0026]

[Example] Hereafter, an example is given and this invention is further explained to a detail.

[0027] Extrusion foaming was carried out from the circular die which prepared the melting polystyrene constituent of the fizz which contains the inorganic filler, PEG-PPG copolymer (the examples 1–3 of a comparison are not included), and foaming agent which are shown in this table in the polystyrene of MI shown in one to examples 1–12 and example of comparison 6 table 1 at the tip of an extruder, the foam of the shape of a tube subsequently acquired after cooling by mandrel air was cleared to the direction of extrusion, and the foaming sheet was obtained.

[0028] The masterbatch method was adopted as mixing with an inorganic filler and polystyrene resin. MI of a masterbatch is united and shown in Table 1. The description of the obtained foaming sheet is shown in Table 2. In addition, the PEG-PPG copolymer used in the example and the example of a comparison has the molecular structure shown by PEG-PPG-PEG, and the thing of average molecular weight 2000 and 80 % of the weight of PEG quantitative formulas was used for it. Moreover, in examples 1, 2, 4, 6, 9, and 10 and the examples 1, 3, 4, and 6 of a comparison, the thing with a mean particle diameter [of a calcium carbonate] of 5 micrometers was used, in examples 3, 5, 7, and 8 and the examples 2 and 5 of a comparison, the thing with a mean particle diameter [of talc] of 1.8–2.0 micrometers was used, and the thing with a mean particle diameter [of talc] of 5–6 micrometers was used in the examples 11 and 12. Moreover, the inorganic filler MB of the examples 5 and 6 of a comparison used the thing of styrene / inorganic filler weight ratios 1/1, and the other inorganic filler MB used the thing of styrene / inorganic filler weight ratios 2/1.

[0029]

[Table 1]

発泡性ポリスチレン樹脂							無機フィラー 配合量(wt %)	P E C - P P C 共重合体 配合量(wt %)	ブタジ (発泡剤) 配合量(wt %)	無機フィラーラーを 添加したマスター 一バッチのM1 (g/10分)
配合量(wt %)	M1 (g/10分)	種類	配合量(wt %)	配合量(wt %)	P E C - P P C 共重合体 配合量(wt %)	配合量(wt %)				
1 6 7	4	炭酸カルシウム	3 3	0 5	0 4	0 4				
2 8 3	4	炭酸カルシウム	1 7	0 5	0 4	0 4				
3 6 7	4	タルク	3 3	0 5	0 4	0 4				
4 6 7	1 0	炭酸カルシウム	3 3	0 5	0 4	0 4				
5 6 7	1 0	タルク	3 3	0 5	0 4	0 4				
6 6 7	2 0	炭酸カルシウム	3 3	0 5	0 4	0 4				
7 6 7	2 0	タルク	3 3	0 5	0 4	0 4				
8 6 7	4	タルク	3 3	0 5	1 1	3 1				
9 6 7	4	炭酸カルシウム	3 3	0 5	1 2	2 3				
10 6 7	4	炭酸カルシウム	3 3	1 0	1 2	2 3				
例 11 8 0	1 0	タルク	2 0	0 5	0 3 5	5 4				
比 12 8 0	1 0	タルク	2 0	0 3 3	0 3 5	5 4				
較 1 6 7	4	炭酸カルシウム	3 3	0	0 4 7	2 3				
2 6 7	4	タルク	3 3	0	1 1	3 1				
3 6 7	4	炭酸カルシウム	3 3	0	1 2	2 3				
4 6 7	4	炭酸カルシウム	3 3	1 3	0 7 4	2 3				
5 5 0	4	タルク	5 0	1 0	1 0	<3 1				
6 5 0	4	炭酸カルシウム	5 0	1 0	1 0	<2 3				

[0030]
[Table 2]

					備 考
	密度 (g/cm ³)	倍率 (倍)	厚さ (mm)	平均気泡径 (μm)	
実施例	1 0.098	1.6	1.7	1.20	独立気泡率 85%以上
	2 0.094	1.3	1.5	1.80	"
	3 0.100	1.6	1.6	7.0	"
	4 0.101	1.6	1.6	1.00	"
	5 0.090	1.8	1.8	4.0	"
	6 0.093	1.7	1.9	1.20	"
比較例	7 0.095	1.7	2.2	5.0	"
	8 0.176	9	1.6	3.0	"
	9 0.147	1.1	1.9	9.0	"
	10 0.175	9	1.6	1.20	"
	11 0.357	4	1.5	8.0	"
	12 0.280	5	1.4	1.10	"
比較	1 0.095	1.7	1.5	2.5	コルゲート発生、独立気泡率 80%
	2 —	—	—	—	伸びが悪く取り不可(コルゲート発生)
	3 —	—	—	—	伸びが悪く取り不可(コルゲート発生)
	4 —	—	—	—	押出機内での樹脂のすべりによる吐出低下により発泡できず
	5 —	—	—	—	樹脂粘度が高過ぎて発泡できず
	6 —	—	—	—	樹脂粘度が高過ぎて発泡できず

[0031] The result of having measured the tensile strength of the cross direction (the direction of TD) of the foaming sheet obtained in the examples 1, 4, and 6 and the direction of extrusion (the direction of MD) is shown in Table 3.

[0032]

[Table 3]

		実施例 1	実施例 2	実施例 3
引張強さ (kgf/cm ²)	MD方向 TD方向	4.7 1.8	4.8 1.8	4.1 1.6

[0033] The tensile strength of a foaming sheet is JIS. K7113 The average of the result of having

performed the tension test and having measured the piece of a sample with a width of face [according to a No. 1 test piece] of 100mm the condition for speed-of-testing/of 10mm (n:4) was shown.

[0034] Moreover, the result of having examined the flammability of the polystyrene foaming sheet of elegance conventionally which does not contain the foaming sheet and the inorganic filler of an example 11 is shown in Table 4. The inflammable trial of a foaming sheet is JIS. It carried out according to D1201.

[0035]

[Table 4]

		実施例 1 1	従来品
タルク含有量 (重量%)		2 0	0
坪量 (g/m ²)		5 2 0	2 0 0
厚さ (mm)		1. 5	2. 3
密度 (g/cm ³)		0. 3 5 7	0. 8 7
燃焼速度 (mm/分)	MD方向	1 0 1	2 0 3
	TD方向	1 2 3	1 2 4

[0036]

[Effect of the Invention] As explained above, this invention approach by having adopted the approach to which a low-pressure area is made to carry out extrusion foaming of the melting polystyrene system resin of the fizz which contains an inorganic filler and a PEG-PPG copolymer at a specific rate from an extruder A combustion calorie can be made to make it low, without air bubbles' making it detailed, corrugated one arising, air bubbles' being destroyed by the inorganic filler, or there being no fear, like a foaming sheet becomes weak at the time of extrusion foaming, and falling the description of a foaming sheet at it. Moreover, since, as for a PEG-PPG copolymer, safety does not have a problem on food sanitation hygiene highly, the foaming sheet obtained by this invention has the effectiveness of being able to use suitably as an object for food packing container shaping.

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TECHNICAL FIELD

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MEANS

[Means for Solving the Problem] Namely, the manufacture approach of the inorganic filler quantity restoration polystyrene system resin foaming sheet of this invention The melting polystyrene system resin of the fizz containing 10 – 40% of the weight of an inorganic filler, and 0.1 – 1.5% of the weight of a volatile foaming agent and 0.1 – 1.0% of the weight of a polyethylene-glycol-polypropylene-glycol copolymer A low-pressure area carries out extrusion foaming from the inside of an extruder, and it is characterized by obtaining the foaming sheet of 3 and thickness of 0.7–2.0mm with a consistency of 0.1–0.5g [/cm], and 30–300 micrometers of diameters of average air bubbles.

[0009] As polystyrene system resin used in this invention, a copolymer with other vinyl monomers, such as a polymer of alkenyl aromatic compounds, such as polystyrene and PORIPA lame chill styrene, an alkenyl aromatic compound, an acrylic acid, a methacrylic acid and a maleic anhydride, and acrylonitrile, etc. is mentioned, for example. In this invention, parts for rubber, such as a styrene-butadiene-rubber block copolymer, a styrene-butadiene-rubber random copolymer, butadiene rubber, ethylene-propylene rubber, ethylene rubber, and polyisoprene rubber, can also be added to the above-mentioned polystyrene system resin. As for a rubber component, it is desirable to add about 0.3 to 10% of the weight to polystyrene system resin.

[0010] As an inorganic filler used for this invention, talc, a calcium carbonate, a magnesium carbonate, carbon black, clay, etc. can use the general inorganic filler used for this kind of application from before. The particle size of the inorganic filler used changes with classes of inorganic filler. Although it is about 0.5–100 micrometers in mean particle diameter, in the case of talc, in the case of the mean particle diameter of 1.5–15 micrometers, and a calcium carbonate, a thing with a mean particle diameter of 1.5–6.0 micrometers is generally, desirable, for example.

[0011] The polyethylene-glycol-polypropylene-glycol copolymer (it is hereafter called a PEG-PPG copolymer for short.) added in polystyrene system resin with the above-mentioned inorganic filler is a block copolymer of ethyleneoxide and propylene oxide, and is known as a high molecular surface active agent. By using a PEG-PPG copolymer together with an inorganic filler, by improving familiarity by the interface of an inorganic filler and polystyrene system resin, and foaming effectiveness's improving, and improving the solubility to the resin of a foaming agent, the diameter of air bubbles is enlarged and it is thought that corrugated generating is prevented. Especially a PEG-PPG copolymer has [1000 or more things] effectiveness in corrugated prevention and has the desirable weight average molecular weight of a PPG component. The rates of the PEG component and PPG component in a PEG-PPG copolymer are 80:20–10:90 in a weight ratio. Moreover, as a PEG-PPG copolymer, the thing of the both-ends PEG mold with which the PEG component was combined with the both sides of a PPG component is desirable.

[0012] The content in expandable polystyrene system resin adds the above-mentioned inorganic filler and a PEG-PPG copolymer, respectively so that it may become 10 – 40 % of the weight, and 0.1 – 1.0 % of the weight.

[0013] It may reduce the combustion calorie of a polystyrene system resin foaming sheet so that an inorganic filler has many additions, but since air bubbles make it detailed, corrugated one will occur, or decline in the rate of a closed cell or foaming effectiveness will be caused and the moldability and many physical properties of a sheet will fall further if an inorganic filler also has

the operation as a nucleating additive and it is made to contain so much, generally the addition of an inorganic filler is less than 5 % of the weight. The relation between the addition of an inorganic filler at the time of adding an inorganic filler and the combustion calorie of a foaming sheet is shown in a polystyrene foaming sheet at drawing 1.

[0014] On the other hand, although a foaming sheet becomes [the appearance of a sheet] poor and is not desirable even if air bubbles are too coarse, a foaming sheet also with a good appearance is obtained by this invention approach, without causing the fall of corrugated generating, the rate of a closed cell, foaming effectiveness, a moldability, and many physical properties in the range whose content of an inorganic filler is 1 - 40 % of the weight by having used together with the PEG-PPG copolymer. However, when the content of an inorganic filler exceeds 40 % of the weight, while kneading of a constituent becomes difficult also by this invention approach, since the elongation of a sheet worsens, extrusion-foaming nature and the moldability of a sheet fall and effectiveness of a fall of a combustion calorie cannot be conversely desired at less than 10 % of the weight, it is not desirable. The desirable content of the inorganic filler in a fizz resin constituent is 10 - 35 % of the weight.

[0015] Although the elongation at the time of foaming worsens, cutting of a sheet etc. will arise at the time of the taking over of a foaming sheet or a moldability will tend to become poor when there are many especially amounts of an inorganic filler if it fills up with an inorganic filler into a fizz resin constituent, the elongation of a foaming sheet is improved by addition of a PEG-PPG copolymer. However, since the slipping phenomenon of resin arises within an extruder, and sufficient discharge quantity is not obtained but it will be in the condition of extrusion-foaming impossible if the addition of a PEG-PPG copolymer can prevent neither corrugated generating accompanying the brittle problem and detailed-izing of air bubbles which are produced by having added the inorganic filler at less than 0.1 % of the weight, nor the decline in foaming effectiveness but exceeds 1.0 % of the weight conversely, it is not desirable.

[0016] as an approach of adding and kneading an inorganic filler to polystyrene system resin, the dryblend method, the masterbatch method (the following and MB — it is called law for short.), etc. mention — having — MB — it is desirable when law raises the addition of an inorganic filler. Moreover, the addition of an inorganic filler can be raised also by using the large talc of slippage etc. as an inorganic filler. [0017] When adopting the describing [above] MB method, brittleness, such as tensile strength of a foaming sheet, can be improved by making into 2 - 12g / 10 minutes MI of the masterbatch (MB) in which MI contains an inorganic filler, using the thing for 4-15g / 10 minutes as base material resin.

[0018] As an volatile foaming agent used in this invention approach, halogenated hydrocarbon, such as aliphatic hydrocarbon [, such as a propane, butane, a pentane, a hexane and a heptane], trichloromonofluoromethane, dichlorodifluoromethane, 1, and 1-difluoro-1-chloroethane, 1, and 1-difluoroethane, 1, 2-tetrafluoro ethane, 1, 1 and 1, 2-tetrafluoro-2-chloroethane, difluoro chloromethane, a methyl chloride, and a methylene chloride, etc. is mentioned. When trichloromonofluoromethane and a dichlorodifluoromethane are used as a foaming agent Although there are few possibilities that corrugated one etc. may occur even if it makes an inorganic filler contain so much, since trichloromonofluoromethane, a dichlorodifluoromethane, etc. produce the environmental problem of ozone layer depletion among halogenated hydrocarbon, The difluoro chloromethane which destroys neither aliphatic hydrocarbon nor an ozone layer as an volatile foaming agent, It is desirable to use halogenated hydrocarbon, such as 1, 1, 1, 2-tetrafluoro-2-chloroethane, 1, 1 and 1, 2-tetrafluoro ethane, 1, and 1-difluoroethane, 1, and 1-difluoro-1-chloroethane.

[0019] In addition, in this invention, foaming agents, such as a carbon dioxide, nitrogen, and water, can also be used together with an volatile foaming agent. 0.1 to 1.5% of the weight, preferably, the content in a resin constituent adds an volatile foaming agent so that it may become 0.3 - 0.5 % of the weight.

[0020] Although the melting polystyrene system resin of the fizz containing the above-mentioned inorganic filler, a PEG-PPG copolymer, and a foaming agent is made to extrude and foam to a low-pressure area from the inside of an extruder and a foaming sheet is obtained by this invention approach, this foaming sheet is a consistency 0.1 - 0.5 g/cm³, the thickness of

0.7–2.0mm, and 30–300 micrometers of diameters of average air bubbles, and is 40–200 micrometers of diameters of average air bubbles preferably.

[0021] While corrugated generating prevention conjointly is achieved with having used together the inorganic filler and PEG-PPG copolymer of the amount of specification by making the consistency of a foaming sheet, thickness, and the diameter of average air bubbles into the above-mentioned range, even if it contains the inorganic filler so much, the brittleness of a foaming sheet etc. is improved, a moldability becomes good and, moreover, appearances, such as smooth nature, also become good. Furthermore, while destruction of the cellular film by the inorganic filler is prevented, as a result of the compatibility of a foaming agent and resin becoming good, stable extrusion foaming becomes possible and fluctuation of expansion ratio decreases.

[0022] Combination, such as a class (difference in MI etc.) of the addition of an inorganic filler, the class of foaming agent, an addition, and base material resin, can adjust the consistency of the above-mentioned foaming sheet. Although adjustment of the consistency at the time of foaming will generally become difficult if an inorganic filler is added, density regulation of the foaming sheet obtained can be easily performed by having used the PEG-PPG copolymer together. Moreover, the thickness of a foaming sheet is determined by adjustment of the discharge quantity of an extruder, and the interrelation of the taking over rate of an extrusion-foaming object. Furthermore, the diameter of average air bubbles of a foaming sheet is adjusted by combination, such as an addition of an inorganic filler, a class, and a class of foaming agent.

[0023] The method of carrying out extrusion foaming, obtaining tube-like foam, clearing the foam of the shape of this tube along with the direction of extrusion subsequently, and usually obtaining a sheet from the circular die at the tip of an extruder, as an approach of obtaining a foaming sheet, is adopted.

[0024] In addition, since the foaming sheet obtained in this invention approach contains an inorganic filler, it asks for expansion ratio from the consistency of this foaming sheet from the following and the formula shown by several 1.

[0025]

[Equation 1]

$$\text{発泡倍率(倍)} = \frac{1.05 \text{ (g/cm}^3\text{)}}{\text{シートの密度 (g/cm}^3\text{) } \times (100 - \text{フィラーコンテンツ \%}) / 100}$$

[Translation done.]

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EXAMPLE

[Example] Hereafter, an example is given and this invention is further explained to a detail.
[0027] Extrusion foaming was carried out from the circular die which prepared the melting polystyrene constituent of the fizz which contains the inorganic filler, PEG-PPG copolymer (the examples 1-3 of a comparison are not included), and foaming agent which are shown in this table in the polystyrene of MI shown in one to examples 1-12 and example of comparison 6 table 1 at the tip of an extruder, the foam of the shape of a tube subsequently acquired after cooling by mandrel air was cleared to the direction of extrusion, and the foaming sheet was obtained.
[0028] The masterbatch method was adopted as mixing with an inorganic filler and polystyrene resin. MI of a masterbatch is united and shown in Table 1. The description of the obtained foaming sheet is shown in Table 2. In addition, the PEG-PPG copolymer used in the example and the example of a comparison has the molecular structure shown by PEG-PPG-PEG, and the thing of average molecular weight 2000 and 80 % of the weight of PEG quantitative formulas was used for it. Moreover, in examples 1, 2, 4, 6, 9, and 10 and the examples 1, 3, 4, and 6 of a comparison, the thing with a mean particle diameter [of a calcium carbonate] of 5 micrometers was used, in examples 3, 5, 7, and 8 and the examples 2 and 5 of a comparison, the thing with a mean particle diameter [of talc] of 1.8-2.0 micrometers was used, and the thing with a mean particle diameter [of talc] of 5-6 micrometers was used in the examples 11 and 12. Moreover, the inorganic filler MB of the examples 5 and 6 of a comparison used the thing of styrene / inorganic filler weight ratios 1/1, and the other inorganic filler MB used the thing of styrene / inorganic filler weight ratios 2/1.

[0029]

[Table 1]

第泡性ポリスチレン樹脂									
		無機フィラー			PEG-PPG (発泡剤) 配合量(wt %)				
	配合量(wt %)	M1 (g/10分)	種類	配合量(wt %)	共重合体(wt %)	配合量(wt %)	ブタン (発泡剤) 配合量(wt %)	無機フィラースターバッヂのM1 を無機フィラースターバッヂのM1 添加したマス(1分)	
実施例	1 67	4	炭酸カルシウム	3 3	0.5	0.4	0.4	2.3	
	2 83	4	炭酸カルシウム	1 7	0.5	0.4	0.4	2.3	
	3 67	4	タルク	3 3	0.5	0.4	0.4	3.1	
	4 67	1 0	炭酸カルシウム	3 3	0.5	0.4	0.4	4.3	
	5 87	1 0	タルク	3 3	0.5	0.4	0.4	5.2	
	6 67	2 0	炭酸カルシウム	3 3	0.5	0.4	0.4	12.9	
比較例	7 87	2 0	タルク	3 3	0.5	0.4	0.4	16.0	
	8 67	4	タルク	3 3	0.5	1.1	3.1		
	9 67	4	炭酸カルシウム	3 3	0.5	1.2	2.3		
	10 67	4	炭酸カルシウム	3 3	1.0	1.2	2.3		
	11 80	1 0	タルク	2 0	0.5	0.35	5.4		
	12 80	1 0	タルク	2 0	0.33	0.35	5.4		
較差例	1 67	4	炭酸カルシウム	3 3	0	0.47	2.3		
	2 67	4	タルク	3 3	0	1.1	3.1		
	3 67	4	炭酸カルシウム	3 3	0	1.2	2.3		
	4 67	4	炭酸カルシウム	3 3	1.3	0.74	2.3		
	5 50	4	タルク	5 0	1.0	1.0	<3.1		
	6 50	4	炭酸カルシウム	5 0	1.0	1.0	<2.3		

[0030]
[Table 2]

備 考				
	密 度 (g/cm ³)	倍 率 (倍)	厚 み (mm)	平均気泡径 (μm)
実 施 例	1 0.099	1.6	1.7	1.20 独立気泡率 85%以上
	2 0.094	1.3	1.5	1.80 "
	3 0.100	1.6	1.6	7.0 "
	4 0.101	1.6	1.6	1.00 "
	5 0.090	1.8	1.8	4.0 "
	6 0.093	1.7	1.9	1.20 "
	7 0.095	1.7	2.2	5.0 "
	8 0.176	9	1.6	3.0 "
	9 0.147	11	1.9	9.0 "
	10 0.175	9	1.6	1.20 "
	11 0.357	4	1.5	8.0 "
	12 0.280	5	1.4	1.10 "
比 数 例	1 0.095	1.7	1.5	2.5 コルゲート発生、独立気泡率 80%
	2 —	—	—	— 伸びが悪く引取り不可(コルゲート発生)
	3 —	—	—	— 伸びが悪く引取り不可(コルゲート発生)
	4 —	—	—	— 壓出筒内での接着のスベリによる吐出低下により発泡できず
	5 —	—	—	— 树脂粘度が高過ぎて発泡できず
	6 —	—	—	— 树脂粘度が高過ぎて発泡できず

[0031] The result of having measured the tensile strength of the cross direction (the direction of TD) of the foaming sheet obtained in the examples 1, 4, and 6 and the direction of extrusion (the direction of MD) is shown in Table 3.

[0032]

[Table 3]

		実施例 1	実施例 2	実施例 3
引張強さ (kgf/cm ²)	MD方向 TD方向	4.7 1.8	4.8 1.8	4.1 1.6

[0033] The tensile strength of a foaming sheet is JIS. K7113 The average of the result of having

performed the tension test and having measured the piece of a sample with a width of face [according to a No. 1 test piece] of 100mm the condition for speed-of-testing/of 10mm (n:4) was shown.

[0034] Moreover, the result of having examined the flammability of the polystyrene foaming sheet of elegance conventionally which does not contain the foaming sheet and the inorganic filler of an example 11 is shown in Table 4. The inflammable trial of a foaming sheet is JIS. It carried out according to D1201.

[0035]

[Table 4]

		実施例 11	従来品
タルク含有量 (重量%)		2 0	0
坪量 (g/m ²)		5 2 0	2 0 0
厚さ (mm)		1. 5	2. 3
密度 (g/cm ³)		0. 3 5 7	0. 8 7
燃焼速度 (mm/分)	MD方向	1 0 1	2 0 3
	TD方向	1 2 3	1 2 4

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the graph which shows the relation between the content of an inorganic filler, and a combustion calorie.

[Translation done.]

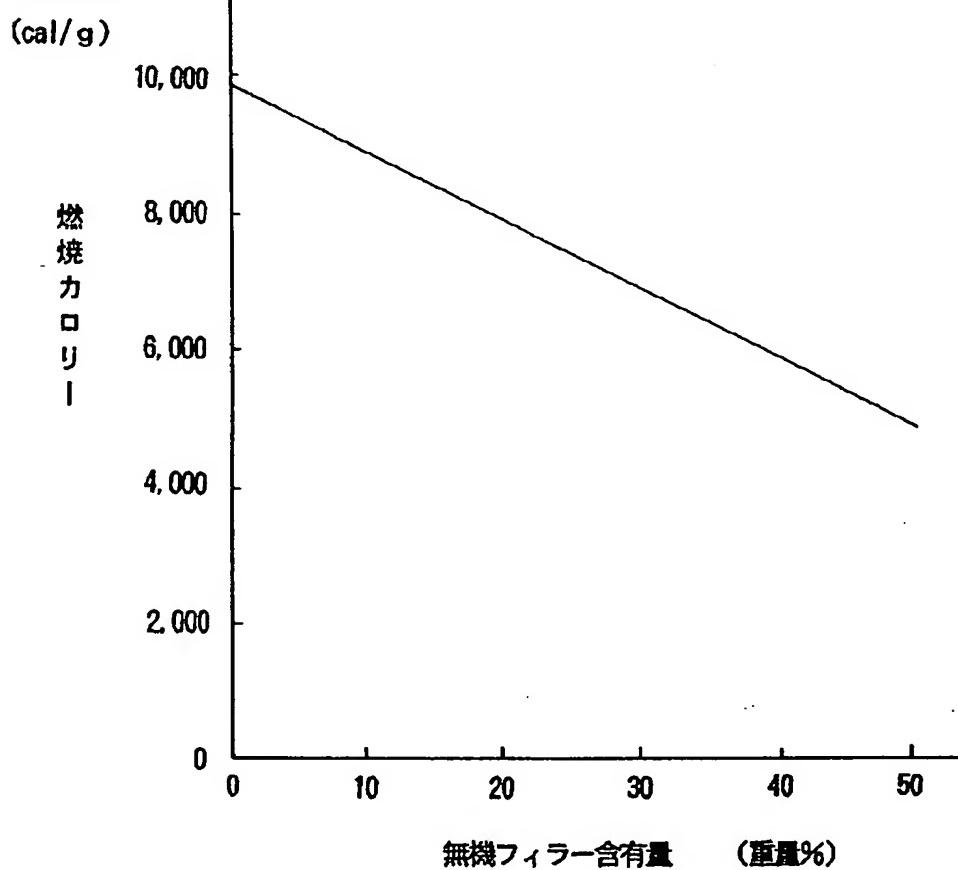
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DRAWINGS

[Drawing 1]



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